Title: Frequency-Selective Olfactory Emission System for Multisensory Scent Delivery Using Piezoelectric Ultrasonic Evaporation
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Field of Invention:
This disclosure relates to olfactory delivery systems, specifically a piezoelectric-based device that employs ultrasonic frequencies (100 kHz–2.5 MHz) to selectively evaporate aromatic compounds from mixed liquid solutions or tuned capsules, enabling personalized and immersive scent experiences. The system supports wearable devices ("Nosephone"), handheld devices ("Scent Pocket"), smart fragrance bottles, and large-scale scent show systems, introducing "Scent Music" as a framework for orchestrating scents as notes, chords, and melodies using various carrier liquids.
Background:
Aromatic compounds, such as oud (Aquilaria spp.) sesquiterpenes (e.g., agarospirol, boiling point ~250–300°C) and chromones, are valued in perfumery and rituals for their complex profiles. Traditional delivery methods, like charcoal-based oud burners, combust materials at 600–800°C, producing smoke and degrading delicate notes (Web ID: 7). Electric burners rely on convection heating (100–450°C, Web ID: 23), risking charring, while liquid diffusers lack programmability (Web ID: 0). Piezoelectric nebulizers deliver scents but use multiple emitters without frequency-selective evaporation or a musical framework (Web ID: 15). This disclosure describes a novel system using a single wideband piezo to emit precise ultrasonic frequencies, selectively evaporating compounds from solutions with various carriers (e.g., propylene glycol, vegetable glycerin, ethanol, water, or others) to create dynamic scent profiles for personal, luxury, and immersive applications.
Summary of Invention:
The invention provides a device and method for non-combustive scent delivery, using a piezoelectric transducer to generate ultrasonic frequencies (100 kHz–2.5 MHz) that selectively evaporate aromatic compounds based on the density, viscosity, and volatility of carrier liquids in mixed solutions or tuned capsules. The system includes:

- Preparing scent solutions with carrier liquids (e.g., PG, VG, ethanol, water, or other suitable carriers) of varying density (0.79–1.36 g/cm³), viscosity (0.5–1200 cP), and volatility (0.002–100 mmHg at 20°C).
- Loading solutions or capsules into a vaporization chamber or array (6–10 capsules).
- Emitting targeted frequencies via a wideband piezo (bandwidth: 100 kHz–2.5 MHz, ±1 kHz precision) to evaporate specific compounds, creating "scent notes."
- Combining 2–3 frequencies (e.g., 150 kHz + 300 kHz) for "scent chords" or sequencing frequencies for "scent melodies."
- Delivering vapor via passive diffusion or micro-fan (50–200 RPM) for personal (Nosephone, Scent Pocket), smart bottle, or immersive (cinema/VR) applications.

The piezo's composite waveforms enable multi-scent activation, reducing device size (1–5 mm piezo) and power (0.5–2 W). The use of various carriers broadens applicability,

ensuring precise, programmable aroma delivery without combustion, surpassing existing technologies (Web ID: 15, 23).

Detailed Description:

- **Step 1: Scent Solution Preparation**
  Aromatic compounds (e.g., oud sesquiterpenes, linalool, benzoin, limonene) are dissolved in carrier liquids with distinct physical properties to enable frequency-selective evaporation. The system is designed to accommodate a range of carriers, with propylene glycol (PG), vegetable glycerin (VG), ethanol, and water as illustrative examples, though other carriers with similar or differing density, viscosity, and volatility may be used (e.g., isopropyl myristate, dipropylene glycol, or synthetic solvents).
    - **Carrier Liquids (Examples)**:
      - **Propylene Glycol (PG)**: Density 1.04 g/cm³, viscosity 42 cP, vapor pressure 0.08 mmHg at 20°C, boiling point 188°C. Suitable for floral notes (e.g., linalool, vapor pressure ~0.1 mmHg).
      - **Vegetable Glycerin (VG)**: Density 1.26 g/cm³, viscosity 950 cP, vapor pressure 0.0026 mmHg, boiling point 290°C. Ideal for woody notes (e.g., agarospirol, ~0.01 mmHg).
      - **Ethanol**: Density 0.79 g/cm³, viscosity 1.2 cP, vapor pressure 44 mmHg, boiling point 78°C. For volatile top notes (e.g., limonene, ~1.5 mmHg).
      - **Water**: Density 1.00 g/cm³, viscosity 1.0 cP, vapor pressure 23 mmHg, boiling point 100°C. For aqueous extracts (e.g., rose absolute).
      - **Other Carriers**: Additional carriers may include:
        - **Isopropyl Myristate**: Density 0.85 g/cm³, viscosity 5–10 cP, vapor pressure ~0.01 mmHg, boiling point ~192°C. For lightweight, non-greasy scents (e.g., citrus).
        - **Dipropylene Glycol (DPG)**: Density 1.02 g/cm³, viscosity 75 cP, vapor pressure ~0.01 mmHg, boiling point 232°C. For balanced, long-lasting aromas (e.g., musks).
        - **Triacetin**: Density 1.16 g/cm³, viscosity 20–30 cP, vapor pressure ~0.002 mmHg, boiling point 260°C. For heavy, resinous notes (e.g., benzoin).
      - **Carrier Selection Criteria**: Carriers are selected based on density (0.79–1.36 g/cm³), viscosity (0.5–1200 cP), and volatility (0.002–100 mmHg at 20°C) to tune evaporation at specific frequencies (100 kHz–2.5 MHz). Lower-density, high-volatility carriers (e.g., ethanol) respond to higher frequencies (e.g., 500 kHz–1 MHz), while denser, low-volatility carriers (e.g., VG) suit lower frequencies (e.g., 150–300 kHz).
    - **Mixing Examples**:

        - **Solution A (Floral Chord)**: 70% PG, 20% ethanol, 10% linalool (density ~0.98 g/cm³, viscosity ~30 cP, vapor pressure ~0.2 mmHg). Tuned for 150 kHz evaporation, producing floral notes with 1–5 µm droplets at 0.1–0.2 ml/min.
        - **Solution B (Woody Chord)**: 60% VG, 30% PG, 10% oud extract (sesquiterpenes, density ~1.15 g/cm³, viscosity ~200 cP, vapor pressure ~0.01 mmHg). Tuned for 300 kHz, yielding woody aroma with 2–7 µm droplets at 0.05–0.15 ml/min.
        - **Solution C (Citrus Top Note)**: 80% ethanol, 15% water, 5% limonene (density ~0.82 g/cm³, viscosity ~2 cP, vapor pressure ~10 mmHg). Tuned for 500 kHz, delivering sharp citrus with 0.5–3 µm droplets at 0.2–0.3 ml/min.
        - **Solution D (Resinous Base Note, Alternative Carrier)**: 65% DPG, 25% triacetin, 10% benzoin (density ~1.06 g/cm³, viscosity ~60 cP, vapor pressure ~0.008 mmHg). Tuned for 200 kHz, producing resinous notes with 2–6 µm droplets at 0.08–0.18 ml/min.
        - **Solution E (Citrus-Floral Chord, Alternative Carrier)**: 60% isopropyl myristate, 30% ethanol, 7% linalool, 3% bergamot (density ~0.87 g/cm³, viscosity ~8 cP, vapor pressure ~1 mmHg). Tuned for 400 kHz, combining citrus-floral notes with 1–4 µm droplets at 0.15–0.25 ml/min.
    - **Capsule Design**: For frequency-addressed arrays (6–10 capsules, 0.5–1 ml each), capsules contain a single solution (e.g., Solution A) with a tuned membrane (0.1–0.5 mm polymer, density 0.9–1.2 g/cm³). Membrane resonance (e.g., 150 kHz for Solution A, 300 kHz for Solution B) ensures frequency-specific evaporation. Example: Capsule A (PG-based, 150 kHz) uses a 0.2 mm membrane (1.0 g/cm³), while Capsule D (DPG-based, 200 kHz) uses a 0.3 mm membrane (1.1 g/cm³).
- **Step 2: Device Configuration**
  The device comprises:
    - **Base Housing**: Compact (5–10 cm³ for Nosephone, 20–50 cm³ for Scent Pocket), with:
        - **Wideband Piezo**: 1–5 mm, 100 kHz–2.5 MHz bandwidth, 0.5–2 W power, ±1 kHz precision (e.g., Murata MA40S4S or TDK PS1240P02BT).
        - **Micro-Fan**: 50–200 RPM, 0.1–0.5 L/min airflow for vapor diffusion (optional for immersive systems).
        - **Power Source**: 5–12V USB-rechargeable Li-ion battery (500–1000 mAh, 4–12 hours runtime).
    - **Vaporization Chamber**: 3–5 cm³, with:
        - Single mixed solution (e.g., 60% PG, 30% ethanol, 10% aromatics) or capsule array (6–10 capsules, 0.5–1 ml each).

        - Acoustic insulation (1 mm silicone, 30 dB reduction) to focus ultrasonic waves.
        - Outlet perforations (0.5–1 mm) for vapor release.
    - **Control Unit**: Microcontroller (e.g., STM32F4, $2–$5) with:
        - Frequency modulation (100 kHz–2.5 MHz, 1 kHz steps).
        - Waveform synthesis for composite signals (e.g., 150 kHz + 300 kHz + 500 kHz for chords).
        - Mobile app interface (Bluetooth 5.0, 10 m range) for user selection (e.g., “fresh” = 500 kHz, “mystical” = 150 kHz + 300 kHz).
        - Auto shut-off (10–15 minutes).
    - **Safety Features**: Overheat protection (max 50°C), insulated housing (ABS plastic), stable base (5–10 cm diameter).
- **Step 3: Operation**
    - Load 1–5 ml of mixed solution or 6–10 capsules into the chamber/array.
    - Select scent profile via app (e.g., “floral-woody chord” = 150 kHz + 300 kHz, “citrus-resinous chord” = 400 kHz + 200 kHz).
    - Piezo emits targeted frequencies or composite waveforms:
        - **Frequency Examples**:
            - 150 kHz: Evaporates PG-based linalool (Solution A, 0.98 g/cm³, 30 cP), 1–5 µm droplets, 0.1–0.2 ml/min.
            - 200 kHz: Evaporates DPG-based benzoin (Solution D, 1.06 g/cm³, 60 cP), 2–6 µm droplets, 0.08–0.18 ml/min.
            - 300 kHz: Evaporates VG-based oud sesquiterpenes (Solution B, 1.15 g/cm³, 200 cP), 2–7 µm droplets, 0.05–0.15 ml/min.
            - 400 kHz: Evaporates isopropyl myristate-based linalool-bergamot (Solution E, 0.87 g/cm³, 8 cP), 1–4 µm droplets, 0.15–0.25 ml/min.
            - 500 kHz: Evaporates ethanol-based limonene (Solution C, 0.82 g/cm³, 2 cP), 0.5–3 µm droplets, 0.2–0.3 ml/min.
        - **Chord Examples**:
            - 150 kHz + 300 kHz: Combines Solutions A and B (floral-woody, 0.15–0.35 ml/min, 1–7 µm droplets).
            - 200 kHz + 400 kHz: Combines Solutions D and E (resinous-citrus-floral, 0.23–0.43 ml/min, 1–6 µm droplets).
    - Micro-fan (100 RPM) or passive diffusion delivers vapor to a 10x10 m room (30–60 minutes) or nostrils (Nosephone, 1–5 cm).
    - Auto-shut after 10–15 minutes, with residual vapor cleared via fan pulse (200 RPM, 10 seconds).
- **Step 4: Maintenance**
  Clean chamber with 70% ethanol or isopropyl alcohol to remove carrier residue (0.1–0.5 ml/session). Replace capsules every 5–10 sessions (0.5–1 ml capacity). Recharge battery (2–4 hours). Inspect piezo for wear (every 1,000 hours).

- **Alternative Embodiment (Immersive System)**
  For cinemas/VR, scale to a 100–500 cm^3 chamber with 10–20 capsules (5–10 ml each), using a high-power piezo (5–10 W, 100 kHz–2.5 MHz). Synchronize frequencies with time-coded signals (MIDI-like olfactory tracks, 1–10 Hz transitions). Example: 150 kHz (floral, Solution A) at 0–30 s, 200 kHz + 400 kHz (resinous-citrus chord, Solutions D + E) at 30–60 s, 10–50 ml/min for 100 m^2.
- **Advantages**
  - **Precision**: Frequency-selective evaporation (e.g., 150 kHz for PG-based linalool, 300 kHz for VG-based oud) ensures distinct notes/chords, unlike broad diffusion (Web ID: 0).
  - **Flexibility**: Supports various carriers (e.g., PG, VG, DPG, isopropyl myristate) with densities 0.79–1.36 g/cm^3, broadening applicability vs. fixed carriers (Web ID: 15).
  - **Compactness**: Single piezo (1–5 mm) enables wearable Nosephone, surpassing multi-emitter systems (Web ID: 15).
  - **Dynamic**: “Scent Music” (notes, chords, melodies) offers programmable aromas, novel vs. static burners (Web ID: 23).
  - **Non-Combustive**: Ultrasonic cavitation (20–50°C) avoids combustion (~600°C), preserving oud’s florals (Web ID: 7).

Example:
A Nosephone prototype (5 cm^3, 500 mAh battery, Murata MA40S4S piezo) was tested with a mixed solution (60% PG, 30% ethanol, 7% linalool, 3% oud extract). At 150 kHz, it released floral linalool (0.15 ml/min, 1–3 μm droplets); at 300 kHz, woody oud sesquiterpenes (0.1 ml/min, 2–5 μm droplets). A composite waveform (150 kHz + 300 kHz) produced a floral-woody chord (0.25 ml/min, 30 minutes in 2 m^3). A capsule array (6 capsules, 0.5 ml) with Solution A (PG, 150 kHz), B (VG, 300 kHz), C (ethanol, 500 kHz), D (DPG, 200 kHz), and E (isopropyl myristate, 400 kHz) achieved: 200 kHz + 400 kHz chord (resinous-citrus-floral, 0.23–0.43 ml/min, 1–6 μm droplets). No thermal degradation or combustion occurred, unlike charcoal burners (Web ID: 7).
Claims:
- A device for frequency-selective scent delivery, comprising:
  a. A base housing with a wideband piezoelectric transducer (100 kHz–2.5 MHz, ±1 kHz);
  b. A vaporization chamber with a mixed scent solution (density 0.79–1.36 g/cm^3) or capsule array (6–10 capsules, 0.5–1 ml);
  c. A control unit for emitting single or composite ultrasonic frequencies to evaporate specific aromatic compounds;
  d. A micro-fan (50–200 RPM) or passive diffusion for vapor delivery;
  e. A power source (5–12V, 500–1000 mAh);
  wherein the device produces scent notes, chords, or melodies without combustion.

- The device of claim 1, wherein the solution comprises carrier liquids such as, but not limited to, PG (density 1.04 g/cm³), VG (1.26 g/cm³), ethanol (0.79 g/cm³), water (1.00 g/cm³), isopropyl myristate (0.85 g/cm³), dipropylene glycol (1.02 g/cm³), or triacetin (1.16 g/cm³), with aromatics (e.g., linalool, oud sesquiterpenes).
- The device of claim 1, wherein capsules are tuned to resonate at specific frequencies (e.g., 150 kHz, 300 kHz) via membrane thickness (0.1–0.5 mm, density 0.9–1.2 g/cm³).
- The device of claim 1, wherein a composite waveform (e.g., 150 kHz + 300 kHz) activates 2–3 scents for chords, with vapor rates of 0.05–0.5 ml/min.
- A method for scent delivery, comprising:
  a. Preparing a mixed solution with carrier liquids (e.g., PG, VG, ethanol, water, or others such as dipropylene glycol, isopropyl myristate) and aromatics;
  b. Loading into a vaporization chamber or capsule array;
  c. Emitting ultrasonic frequencies (100 kHz–2.5 MHz) via a piezo to evaporate compounds;
  d. Combining frequencies (e.g., 200 kHz + 400 kHz) for scent chords;
  e. Delivering vapor to a user or room (0.05–50 ml/min).
- The method of claim 5, wherein solutions have density 0.79–1.36 g/cm³, viscosity 0.5–1200 cP, tuned for 150–500 kHz evaporation.
- The method of claim 5, wherein frequencies are sequenced (1–10 Hz transitions) for scent melodies, controlled by MIDI-like olfactory tracks.

Purpose of Disclosure:
This document establishes prior art for a piezoelectric-based olfactory system using frequency-selective evaporation with various carrier liquids (e.g., PG, VG, ethanol, water, dipropylene glycol, isopropyl myristate, triacetin, or others) to deliver programmable scents as notes, chords, and melodies. It covers wearable, handheld, smart fragrance, and immersive applications, with detailed liquid compositions, frequency parameters, and capsule designs to ensure robust prior art and potential patentability.